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(54) Paper treatment composition

(57) The suitability of paper for printing by so-called "colour digital presses" of the kind which use a liquid toner or ink is enhanced by the use of a treatment composition comprising an aluminate salt or a salt of a weak acid and a strong base in an amount such as to impart an alkaline surface pH value to the paper. The treatment composition preferably also contains starch or another surface agent, so that the treatment composition also functions as a surface sizing composition.

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D scription

This invention relates to the use of a treatment composition for enhancing the suitability of paper for printing by so-called "colour digital presses" of the kind which use a liquid toner or ink.

Colour digital presses were first commercialised on a significant scale around the early 1990's. They are particularly suited to short printing runs for which traditional colour offset printing can be uneconomic and slow because of the high cost and time penalties involved in producing printing plates and setting up the press at the start of the run. By contrast, a colour digital press has no printing plates or comparable set-up costs. It therefore permits a rapid response to print orders ("fast turnaround"), and the cost per impression is not significantly influenced by the total number of impressions being made. These factors make a digital press ideal for short-run colour printing, say for up to about 3000 impressions. Since the information to be printed is stored in electronic form ("digitised"), rather than physically on a printing plate, initial and repeat print-runs can be made "on demand" without the need for physical changes to the press. A further benefit is that variable and non-variable information can be merged between every consecutively printed copy, so that individual impressions within a print run can be personalised or customised so as to be specific to a particular recipient or reader.

Colour digital press technology is based on non-impact printing or imaging technology of the same general kind as is used in plain paper photocopiers and laser printers, i.e. on the use of an electrostatically-charged roll and charged toner particles for image formation. An electrostatically-charged photosensitive roll (the "photoreceptor") is exposed to light in an imagewise configuration such that the surface electrostatic charge on the exposed areas of the photoreceptor is dissipated. Toner is then brought into contact with the photoreceptor, and adheres strongly to it in the unexposed (and thus still electrostatically-charged) areas of its surface, from which it can be transferred to the paper either directly or indirectly via an offset roll.

A single pass through the printing unit provides a monochrome image, but a colour print of a quality comparable to that obtainable by traditional colour offset printing can be achieved either by multiple passes through a printing unit using differently-coloured toners or by a single pass through an array of printing units each of which applies a differently-coloured toner. Typically four passes or printing units are used, three of which apply coloured toners and the other of which applies a black toner. The coloured toners are such that when used individually and in suitable combinations, they can provide a complete spectral range for the finished print, in much the same way as is achieved in conventional colour printing by the use of a black and three differently-coloured inks.

Currently-commercialised colour digital presses can be divided into two groups according to the type of toner used, i.e. whether it is a "dry toner" or a "liquid toner". Dry toners are of a fine particulate nature, with each particle comprising pigment particles bound together in a thermally-fusible polymeric binder matrix. Once the toner has been applied to the paper, heat is used to melt the polymeric binder component of the toner and so "fuse" the toner particles together and to the paper. By contrast, liquid toners comprise toner particles dispersed in a fairly high-boiling organic liquid vehicle, together with dispersed binder particles. During the printing operation, most of the vehicle is thought to be removed and the toner is heated to an elevated temperature (typically 70 - 90°C) sufficient to convert the binder particles to a liquid state. Removal of the vehicle results in an increase in toner viscosity, which facilitates transfer of the toner to the offset roll (if used) and to the paper, with the paper surface absorbing the residual liquid vehicle. The binder reverts to a solid state after the toner has been applied to the paper and so fixes the image (there is no subsequent "fusing" of the toner after its transfer to the paper, such as occurs in dry toner processes).

The paper used with colour digital presses must be carefully chosen if good print quality and runnability through the digital press is to be achieved. Where the press is of the kind using dry toner, the paper requirements are similar to those for plain paper copying and laser printing, primarily a smooth surface, good stiffness, a relatively low moisture content, good dimensional stability under conditions of variable humidity, compatibility with toner so as to permit good toner adhesion and ability to withstand the heat of the toner fusing stage without excessive curling, wavy edge production or blistering. Such papers are readily available at acceptable cost, and so paper availability has not been a significant constraint on market penetration of dry toner colour digital press technology.

The position is rather different in the case of colour digital presses using liquid toners for image formation. Very good results are obtainable with pigment-coated printing papers, but ordinary commercially available uncoated printing and office papers do not give such good results. The main problems are the achievement of good transfer of toner to the paper and subsequent adhesion of toner to the paper. These constraints are serious, since for many applications or end uses the use of uncoated papers is preferred for aesthetic or other reasons.

There is therefore a requirement for a paper which is not conventionally pigment-coated but which nevertheless offers good print performance with liquid toner colour digital presses.

We have now developed a paper treatment composition which, when applied to a suitable base paper substrate, results in significantly enhanced suitability for printing by liquid toner colour digital presses.

In a first aspect therefore, the invention resides in the use, for the purpose of enhancing the printability of paper by means of a liquid toner colour digital press, of a treatment composition comprising an aluminate salt or a salt of a

weak acid and a strong base in an amount such as to impart an alkaline surface pH value to the paper.

In a second aspect, the invention provides a method of printing paper by means of a liquid toner colour digital press, characterised in that the paper being printed has been surface treated with an aluminate salt or a salt of a weak acid and a strong base in an amount such as to give an alkaline surface pH value.

The treatment composition comprising the aluminate salt or the salt of a weak acid and a strong base preferably contains starch or another surface agent, so that the treatment composition also functions as a surface sizing composition. This reduces the cost of the treatment (since no additional paper processing is required beyond the normal size press treatment). It also facilitates uniform application of the active treating ingredient (the salt) across the whole surface of the paper, since the sizing agent functions as an extender. The surface size is typically a starch, but could in principle be a latex, polyvinyl alcohol, gelatin, a cellulose derivative such as carboxymethylcellulose, or other known surface sizing material. Combinations of these materials can be used.

Although size press application is a particularly convenient and therefore preferred method of applying the treatment composition, coating, spraying or other application techniques can be used. Size-presses as referred to in this application include not only traditional size presses but also so-called "metered" size presses of the kind commercialised under the name "Speedsizer" by Voith, "Sym-Sizer" by Valmet, "Twin-HSM" by BTG and "Filmpress" by Jagenberg.

The aluminate salt is preferably sodium aluminate, and the salt of a weak acid and a strong base is preferably sodium hydrogen carbonate (sodium bicarbonate). Less preferred alternatives include disodium tetraborate, trisodium phosphate and sodium acetate. Sodium salts have been referred to because they are the most readily available, but it will be understood that the corresponding potassium salts could equally well be used, as could calcium salts, provided that they are adequately soluble. Sodium aluminate has so far been found to give the best results, possibly because the presence of polyvalent aluminium enhances affinity to toner materials.

Surprisingly, we found that the best results were achieved with a reduced level of starch surface sizing agent compared with that used conventionally in the grades of paper concerned. Thus whereas a starch surface composition typically has a starch concentration of the order of ca. 8%, we found that better results were achieved with a starch surface size concentration of around 2%. Although the pickup of lower concentration surface sizing compositions is normally higher than for more concentrated compositions, the net result is a reduced level of surface size in the paper.

The amount of aluminate salt or salt of a weak acid and a strong base to be used varies in accordance with the type of paper being treated, for example its absorbence and inherent hold-out characteristics and the level and type of internal sizing used. Guidance as to suitable treatment levels is obtainable from the Examples given below. Generally the amount of aluminate or salt of a weak acid and a strong base will be such as to produce an alkaline surface pH value, for example 8 - 8.5 or higher.

Although the present invention seeks to avoid the need for the use of conventionally coated papers with a liquid toner colour digital press, a small amount of pigment (e.g. colloidal precipitated calcium carbonate) can be present in the treatment composition if the effect is not such as to change the fundamental character of the final treated paper, i. e. to convert it from what would be perceived as an "uncoated" grade to a conventional coated product.

The invention will now be illustrated by the following Examples, in which all parts and percentages are by weight unless otherwise specified:

Example 1

A 10% solution was prepared of an oxidised maize starch of the kind conventionally used for surface sizing of paper. This solution was divided into five batches. One of these was used as a control and the others were each made up into treatment compositions according to the invention by the addition of respective salts as listed below:

Salt	Mix Designation
Disodiumtetraborate, $Na_2B_4O_7.10H_2O$	A
Sodium acetate trihydrate, $NaC_2H_3O_2.3H_2O$	B
Trisodium orthophosphate, $Na_3PO_4.12H_2O$	C
Sodium aluminate, $Na_2Al_2O_4$	D
-----	Control

The addition level of the salts was 1% on a dry basis in each case, calculated as weight of dry salt present (as the hydrate form where indicated) in relation to the weight of dry starch present. Starch therefore made up 99% of the treatment composition.

Each treatment composition was airknife-coated on to a smooth wove-finish 100 g m^{-2} business letterhead base paper stock by means of an intermediate-scale pilot coater. This base paper had been internally-sized with alkyl ketene

dimer (i.e. it was neutral/alkaline sized) and had also been conventionally surface-sized. Two different coatweights of treating composition were applied, namely ca. 3 g m^{-2} and ca. 2 g m^{-2} (dry, in both cases). The resulting reels were then sheeted to SRA3 size and test printed on a liquid toner colour digital press (an INDIGO E-PRINT 1000 press supplied by Indigo N.V. of the Netherlands). The extent to which the various samples accepted the ink in a satisfactory manner was assessed visually, and the level of toner adhesion was assessed by "tape pull" and "rub toner adhesion" tests.

In the tape pull test, a length of medium-tack masking tape was applied to the printed area of each sample and then removed. The adhesive surface of the tapes and the areas of the paper from which they had been removed were then examined visually to see how much of the toner had been removed or retained respectively, and the results compared as between the different samples.

In the toner rub adhesion test, printed areas of each sample were rubbed with an ordinary pencil eraser (with the same force and for the same length of time for each sample). The extent to which the print had been dislodged was assessed visually and the results for each sample compared.

It was found that all the test samples gave better ink acceptance and toner adhesion than the control sample. Of the test samples, Mix D (using sodium aluminate) gave significantly better results than Mixes A to C. The lower coatweight samples (2 gm^{-2}) gave better results than the higher (3 g m^{-2}) for all the test samples.

Example 2

This illustrates application of the treatment composition by means of a size press on a full-size papermachine as part of a paper manufacturing operation, rather than in a separate coating operation as in Example 1. The salt used was sodium hydrogen carbonate, $NaHCO_3$.

A batch of 220l of an 8% solution of cationic potato starch was prepared. 3kg sodium hydrogen carbonate were dissolved in this solution with stirring to produce a treating composition of which starch comprised ca. 85%. The resulting composition was fed to the size press of a paper machine producing a 90 g m^{-2} rosin/alum internally sized wove printing paper. The resulting paper was sheeted, printed and tested in the same way as in Example 1.

It was found that the results obtained were comparable to those obtained with sodium aluminate in Example 1.

Example 3

This compares the results obtained with a sodium aluminate treatment composition applied by means of an intermediate scale coater in two different ways, namely by airknife coating and by means of a size press coating head. The treatment composition was prepared as described with reference to Mix D of Example 1 and the dry coatweight applied was ca. 2 g m^{-2} in each case (per side in the case of the size press treated paper). The paper to which the compositions were applied had not been surface sized but was otherwise as in Example 2. After treatment, the paper was sheeted, printed and tested as described in Example 1.

Both treated papers were observed to have better ink acceptance and toner adhesion properties than the control paper from Example 1. Of the two, the size press coated paper was the better, and was judged to be superior to any of the papers evaluated in Examples 1 and 2.

Example 4

This illustrates the use of sodium hydrogen carbonate with a smaller proportion of starch in the treatment composition than in Example 2.

1300 l of a 2% solution of cationic potato starch were made up. 6 kg of sodium hydrogen carbonate were dissolved in this with stirring to produce a treating composition of which the starch comprised ca. 81%. This was applied at the size press of a papermachine producing a 120 g m^{-2} business letterhead wove base paper sized with a proprietary mixture of alkyl ketene dimer and neutral rosin. The resulting paper was sheeted printed and tested as in previous Examples. The ink acceptance and toner adhesion performance was judged to be comparable to that of the sodium aluminate treated paper of Example 1.

Example 5

1300 l of a 2% solution of cationic potato starch were made up. 3 kg of sodium aluminate were dissolved in this with stirring to produce a treating composition of which the starch comprised ca. 90%. This was applied at the size press of a papermachine producing a 100, 120 and 170 g m^{-2} business letterhead wove base papers internally sized as described in Example 4 but with a lower than conventional sizing level. The resulting paper was sheeted, printed and tested as in previous Examples. The ink acceptance and toner adhesion performance was judged to be very good,

and better than that of previous Examples.

Claims

1. The use, for the purpose of enhancing the printability of paper by means of a liquid toner colour digital press, of a treatment composition comprising an aluminate salt or a salt of a weak acid and a strong base in an amount such as to impart an alkaline surface pH value to the paper.

2. The use as claimed in Claim 1, wherein the surface pH value imparted to the paper is at least 8.

3. The use as claimed in Claim 2, wherein the surface pH value imparted to the paper is at least 8.5.

4. The use as claimed in any preceding claim wherein the treatment composition is a surface sizing composition also comprising an aluminate salt or a salt of a weak acid and a strong base.

5. The use as claimed in any preceding claim wherein the surface size comprises a starch.

6. The use as claimed in any preceding claim wherein the surface size comprises a latex, polyvinyl alcohol, gelatin, or a cellulose derivative such as carboxymethylcellulose.

7. The use as claimed in any preceding claim wherein the aluminate salt is sodium aluminate.

8. The use as claimed in Claim 1 wherein the treatment composition comprises sodium aluminate and a cationic starch.

9. The use as claimed in Claim 1 wherein the treatment composition comprises sodium bicarbonate and a cationic starch.

10. A method of printing paper by means of a liquid toner colour digital press, characterised in that the paper being printed has been surface treated with an aluminate salt or a salt of a weak acid and a strong base in an amount such as to give an alkaline surface pH value.

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EUROPEAN SEARCH REPORT

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Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
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TECHNICAL FIELDS SEARCHED (Int.Cl.6)

D21H
B41M
G03G

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	17 September 1999	Bernardo Noriega, F

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X : particularly relevant if taken alone
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